WARSIM 2000 Requirements Decomposition and Functional Description Process and Repository

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1.0 INTRODUCTION.

The DoD Modeling and Simulation Master plan contains a stated objective to "Develop a conceptual model of the mission space (CMMS) for each DoD mission area to provide a common basis for development of consistent and authoritative M&S representations". This overall effort is being led by the Defense Modeling and Simulation Office (DMSO). The DMSO CMMS is intended to be a simulation independent, first level formalization of the real world relevant to military operations. The focus includes identification and definition of authoritative data sources, use of a common set syntax and semantics, and the infrastructure to support the CMMS data system. The Joint Conceptual Model of Mission Space (JCMMS) will provide authoritative descriptions of the joint mission space for subsequent representation in the Joint Simulations System (JSIMS). The Functional Description of Battlespace (FDB) is the Army's contribution to CMMS, in support of WARSIM 2000. The WARSIM Requirements Decomposition and Functional Definition (WRDFD) process will be used to fill the FDB.

2.0 PURPOSE.

The purpose of this document is to describe both the WRDFD and the functional requirements of the FDB. The process described herein has been developed jointly by the Product Manager for the Family of Simulations (PM-FAMSIM) and the Distributed Interactive Simulation Directorate of the National Simulation Center (NSC-D) who are the WARSIM 2000 materiel developer and combat developer, respectively. Although this paper is focused on the role of the government participants, it does address some of the responsibilities of all the organizations involved. The goals of the WARSIM Requirements Decomposition and Functional Description (WRDFD) process are:

- Establish a common and clear understanding of the WARSIM task and data requirements
- Provide a basis for maintaining mutual functionality expectations between the WARSIM user and the developer during development.
- Facilitate the VV&A process during and after WARSIM development

In essence, this process will provide a coherent method to determine and document a subset of real world operational requirements, focused by tasks, and to transform/decompose these requirements into information and knowledge useable for the design and development of software code. A substantial amount of documentation has already been collected/produced related to the requirements development, decomposition, data collection, and simulation development of WARSIM 2000. This document is

intended to synthesize the essential portions of those other documents (see references) and focus the process toward user involvement.

3.0 OVERVIEW.

A generalized process for developing and sustaining the requirements of a combat training simulation is depicted in Figure 3-1. It begins with a simulation-independent, real-world descriptions of the Army Warfighting Domain and proceeds through the development of simulation-dependent domain descriptions of entities and entity behaviors, cognitive processes and synthetic environment characteristics (knowledge acquisition) required to support the training objectives. The process follows with the development of the associated models and algorithms (knowledge engineering) which represent the domain descriptions and concludes with the Verification, Validation and Accreditation of the simulation. Each of the steps in the process results in data products to be stored in one or more component databases which, for the Army, are collectively referred to as the FDB.

Priorities and descriptions developed during this process will be used to define synthetic environment requirements. Also, the task priorities and resulting descriptions will be used in the operational testing and VV&A of the simulation. Finally, as requirements change over the simulation's life cycle, the same process must be used for updating the repository and configuration management.

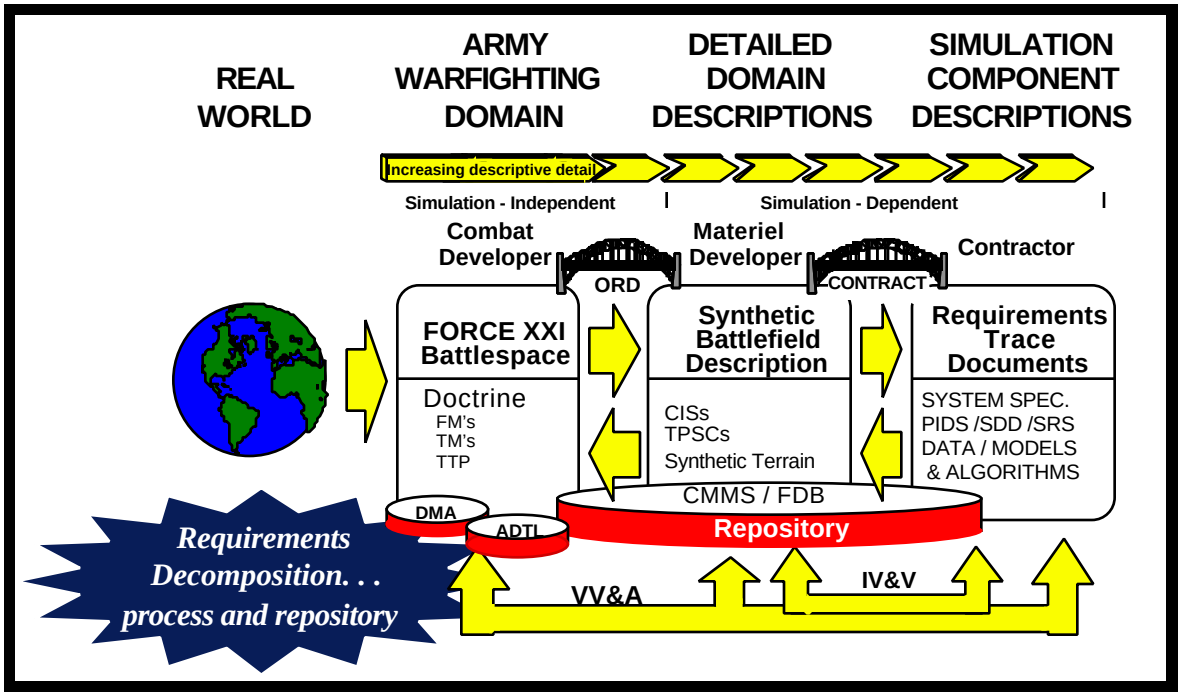

FIGURE 3-1
Requirements Decomposition and
Functional Description Process Overview

3.1 Real World. The real world consists of actual systems, behaviors, and environment.

3.2 Army Warfighting Domain. The Army Warfighter's domain is described in Army FM's, TM's, ARTEP-MTPs, and a host of manuals and pamphlets describing doctrine, tactics, techniques and procedures. Collectively, these documents are the first level of formalization leading to software development. Most of this documentation is or soon will be contained in the Army Digital Training Library (ADTL) or in the Automated Systems Approach to Training (ASAT) and over the Internet. The FDB must be able to either link to the proponent digital libraries or extract their relevant data in order to ensure that the doctrinal manuals and tasks descriptions are the most current versions.

3.3 Detailed Domain Descriptions. An Operational Requirements Document (ORD) for a training simulation generally bridges the gap between the Warfighting Domain and the Detailed Domain Descriptions. It contains extracts of the warfighter domain description and identifies the training audience, the tasks to be trained and the environmental conditions which must be represented in the simulation to support training. However, the level of detail provided in an ORD is generally insufficient for software developers. Software developers require descriptions of the physical, cognitive and environmental characteristics that must be modeled in the code. The level of detail of the descriptions should match the expected level of detail to be included in the model. In CCTT, the added detail was provided by the Combat Instruction Set (CIS) which described acceptable execution of each task required by the ORD. The CISs were written under contract by Subject Matter Experts (SMEs) and then reviewed and approved by the appropriate TRADOC proponent. In this case, the ORD served as the forcing function for the development of the detailed domain descriptions required by the software developer. The FDB Task Process Description (TPD), to be described later, is the logical equivalent of the CCTT CIS for WARSIM.

3.4 Simulation Component Descriptions. The bridge between the Detailed Domain Descriptions and the Simulation Component Descriptions is provided by a contract between the materiel developer and the simulation contractor. This contract contains the simulation specific system specification and is supported by the data and information provided in the FDB. The simulation developer uses the FDB information to design the simulation. At logical intervals in the development process, validation exercises are performed to ensure that the final system will meet user expectations as reflected in the operational requirements. At each of these validation exercises, NSC will provide the system end users to participate in the system review. These exercises will help to identify system anomalies that should be corrected prior to system delivery.

3.5 Information Storage. The FDB is the repository of the domain and simulation component descriptions and their associated data models and algorithms. Since its long range goal is to be a general purpose tool for support of all simulations developments, the FDB will contain both simulation independent and simulation specific information. For this reason, it is expected that the FDB will substantially reduce the scope of front-end analyses for future simulations. The FDB will be described in more detail in paragraph 7.

4.0 KEY PROCESS PARTICIPANTS.

Successful implementation of the WRDFD process described in this paper requires commitment and support by all organizations involved. Significant coordination and cooperation to ensure that WARSIM meets its anticipated functional requirements within cost and schedule constraints is essential.

4.1 STRICOM. STRICOM will serve as the material developer for both WARSIM 2000 and the FDB. The WARSIM 2000, FDB and WRDFD products are managed by STRICOM.

4.2. National Simulation Center. NSC will serve as the combat developer for WARSIM 2000 and the FDB. Subject matter experts are essential to the overall process, particularly to the validation of the domain descriptions and must be under NSC control.

4.3 WARSIM 2000 Contractor. As the prime contractor the WARSIM 2000 developer will be the primary consumer of products developed under the WRDFD process and contained in the FDB. The tasks and priorities of their simulation development schedule and the FDB population schedule must be synchronized.

4.4 FDB contractor. The FDB contractor responsibilities are: to facilitate data collection, transform the source data into useful information and knowledge, and develop the structure to hold, manage and present that information and knowledge in a readily accessible format via an on-line database.

4.5. WRDFD Process Manager. The WRDFD process manager is responsible for correctly applying the NSC approved criteria for selection of the primary training audience, its training tasks and associated represented units and tasks. This responsibility is not yet been assigned to a specific organization.

5.0 WRDFD PROCESS.

The WARSIM 2000 ORD states that, “the simulation system will use a computer-based simulation and associated hardware to support the training of unit commanders and their battle staffs from battalion through theater level....” Because of the potential size and scope of these exercises, a disciplined method must be used to fit this high-level

requirement to allocated funding. The process described below, and depicted in Figure 5-1, is patterned after the JMETL Development process and the CCTT Requirements Decomposition and Functional Definition process. In essence, WRDFD is a task-based implementation of the generalized process described in paragraph 3.

The WARSIM ORD defines the PTA as a unit battlestaff for a single echelon exercise or several unit battlestaffs, for a multi-echelon exercise. It also describes general functional requirements by battlefield operating system. However, the ORD does not define the specific staff sections by unit type or composition. Similarly, the WARSIM System Specification identifies units to be represented together with their "level of representation" and priority (i.e., IOC and FOC), but, it does not explicitly identify the tasks to be performed by the represented units or link the units to the PTA. Thus, neither document explicitly identifies the training audience, their associated tasks, or the tasks to be performed by the

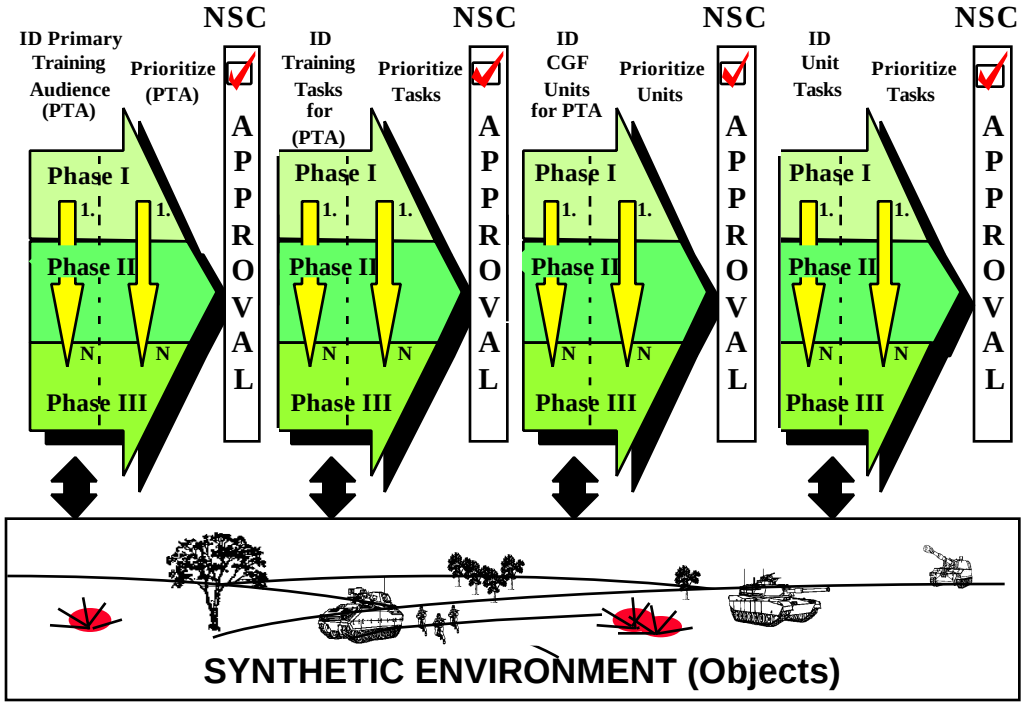

FIGURE 5-1.
WRDFD Process Description

represented units and the required level of detail for each. The specific products to be generated by the WRDFD process include:

- Primary Training Audience and Tasks
- Represented Units and Tasks
- Entities and Physical Behaviors
- Synthetic Environment Objects

Each of these products must be developed with significant consideration given to the required level of detail to support the target simulation system.

5.1 STEP 1: Primary Training Audience (PTA). Identifying of the primary training audience is the first step in the WRDFD process. The global set of PTA members are identified in existing Tables of Organization and Equipment (TOEs) for Headquarters and Headquarters Companies/ Batteries/Troops from battalion through EAC. The current TOE database maintained by TRADOC contains approximately 88 HHC/HHB/HHT TOEs for combat, combat support and combat service support units. This database will be the basis of PTA selection and categorization.

Selection. PTA identification begins with this global set of TOEs and attempts to define and prioritize the subsets which coincide with WARSIM training requirements. Criteria for selecting TOEs and specific staff sections/members from this global set may include historical participation in Battle Command Training Program (BCTP) exercises, participation in joint events, or demands of approved Training Support Packages (see paragraph 6). NSC will define these criteria. Use of these criteria not only provides a systematic means of identifying the PTA members, but also establishes a PTA priority which will prove useful to subsequent steps in the process. As with all subsequent steps, the PTA identification step is not complete without NSC approval.

User Review and Approval. NSC, as the user representative, has the responsibility to review and approve the prioritized PTA list before the next step of identifying the tasks can be accomplished. This review is critical to insure that the user understands the support functions that are required through the role players.

5.2 STEP 2: PTA Training Tasks. Army battle staff tasks are thought by many to be incompletely documented. Nonetheless, the process of identifying and prioritizing PTA tasks should begin by collecting all of those doctrinal tasks which are fully documented within proponent ARTEP Mission Training Plans and the Blueprint of the Battlefield (DA Pam XX-XX, 1 Feb 96) and its Critical Combat Functions. The collected tasks will then be analyzed using separate criteria to be defined by NSC. The majority of the PTA TOEs identified in Step 1 have an associated MTP. These doctrinal sources can be augmented by ARI's Critical Combat Functions for the Heavy Brigade and Task Force, the Battle Staff Training System, the Battle Command Training Program experience, and Project SIMITAR products (e.g., COBRAS). All of these programs and products are focused on Total Army battle staff proficiency and should provide a rich source of battle staff tasks on which to baseline the simulation or help identify additional task requirements.

Completeness and Consistency Analysis**.** The identified battle staff tasks must be linked to their individual staff section members and/or staff groups and a trace analysis conducted to ensure consistency and completeness. To support the overall development process, the trace analysis should focus on the command and control processes common to all echelons. This trace analysis will provide a thread from the highest priority training task through the tasks required from other PTA members and role players to ensure the PTA tasks are supported by the simulation. As an example, if the corps commander is the highest priority training audience and *deliberate attack* is his highest priority training task, then a trace must be developed to show the required tasks of the corps, division, brigade and battalion battle staffs. This thread will grow quickly as the single initiating task spawns numerous required supporting tasks at each lower echelon. Paragraph 6 will address a means to bound this growth. Consistency and completeness is achieved when all supporting tasks have been identified, documented and linked.

Task Traceability**.** To support VV&A of the simulation and facilitate change is doctrine, techniques, tactics and procedures, each battle staff task must be traceable to an approved Army source. Given the quality of battle staff documentation within existing doctrine, this requirement may not be achievable. Nonetheless, this requirement effort will identify the non-doctrinal tasks for debate and inclusion in doctrinal updates by the respective proponents.

Task Performance Support Codes (TPSC). TPSCs should be developed for each task to "establish user expectations". These codes will define the extent that a PTA task will be supported by WARSIM. In the CCTT program, TPSCs were used to define user expectations in terms of operational tasks to be supported in a virtual simulation. Subsequently, they were refined to better describe the extent to which CCTT actually supported each task based on the existence and adequacy of physical cues and responses provided by the virtual synthetic environment. A similar methodology, adapted to a constructive simulation, will be developed for WARSIM.

Review and Approval. Just as with the PTA identification step, PTA tasks and their priorities must be approved by the user.

5.3. STEP 3: Represented Units. The next step in the decomposition process is the identification of the units and equipment to be represented in the simulation to support the PTA in the performance of their selected tasks. This is a key piece in the simulation development because the represented units and equipment dictate the data models and algorithms which must be collected or derived by the simulation developer. For the purposes of this paper, represented units are subdivided into role player units, friendly computer generated forces (CGF) and OPFOR CGF. Both role player and CGF units will be derived from the required PTA training tasks.

Role Player / CGF Units. A role player or CGF unit is a tactical organization for which the cognitive processes are provided by a uniformed trainee or SME. In essence, the role player represents one echelon of command (e.g. battalion). He provides the unit level cognitive (command) processes for his echelon and some degree of control or command override of the next lower echelon units (e.g., companies). The design goal for WARSIM is to minimize the number of role players required to support an exercise. For areas where technology will not support direct PTA to simulation communication, the system should be designed to allow smooth transition to eliminate extra role players when the technology becomes available.

Friendly Represented Units. Friendly Represented Units are fully automated units or entities. They may respond directly to the PTA/STA through their C4I or indirectly through a Role Player's interface. Both cognitive and behavioral models must be built for each of these units.

OPFOR Represented Units. These units will be identified on the basis of the "fair fight" rule. This rule states that neither side will possess a functional advantage due to the absence of countering functional capability on the opposing side. Nor will any PTA member or function be denied training due to the absence of a countering functional capacity. As an example, a threat attack helicopter capacity without a friendly ADA capacity violates the first principle and a friendly ADA capacity with no threat aviation capability violates the second. Thus, for each PTA function, a countering function must be provided in the WARSIM OPFOR units. In addition to the "fair fight" criteria, OPFOR analysis must include the effects of non-aligned, neutral, and other OOTW issues including disaster relief. As with friendly forces, OPFOR units can be commanded semi-automatically by a role player or fully automated CGF.

Review and approval. Represented units should be reviewed and approved jointly by the combat developer, the material developer and the simulation developer before advancing to Step 4.

5.4 STEP 4: Synthetic Environment Requirements. Synthetic environments for constructive simulations have traditionally been low resolution. WARSIM 2000 will be the first major simulation system that interface directly with the units organic C^4I equipment for training. Similar to the represented units and tasks, the synthetic environment requirements should be driven by what is required to support/stimulate the PTA. Three categories of representation are of concern:

Represented Units and Equipment. To support realistic combat resolution and training integration across all BOSs, the WARSIM 2000 design approach relies on platform level interactions. To support these interactions, the simulation must internally operate at higher fidelity terrain resolution than previous constructive simulations. The

internal use refers to the *look*, *move*, and *shoot* actions of the lower level objects - small unit and platforms. The WRDFD process is specifically intended to help identify these objects and, more importantly, their minimally acceptable interactions relating to tasks such assess, sense, acquire. Internally tracking a higher level of fidelity should also support linking with other live and virtual simulations systems that have inherently high fidelity position tracking. This level of fidelity should not be confused with the work station display fidelity mentioned below.

C^{4}I Equipment Requirements. To increase the training benefit of WARSIM 2000, there is a requirement to use the unit's organic C^{4}I equipment as the primary interface between the PTA and the simulation and/or role player/CGF operator. WARSIM synthetic environment representations must be compatible with the needs of the C4I systems used by the PTA and compliant with their data formats. For example, weather is a significant factor in fire support planning and coordination. Therefore, WARSIM must provide AFATDS with weather related data in the AFATDS format. We cannot expect operational C^{4}I equipment to be redesign based on WARSIM requirements nor do we want to create interface requirements.

Display Requirements. WARSIM workstations must support both the role players and CGF operators. To support the role player interactions, the display must have sufficient resolution to allow them to interact with the simulation in a manner consistent with actual battlefield conditions. The specific requirements for these displays will be dependent on the role player tasks as determined through the WRDFD process and not driven by the fidelity of the simulation. The only possible exception to this is the commanders agility function which will require a 3-dimensional view of the battlefield. This exception implies a need for variable resolution monitors. Yet even in this example, the degree of fidelity in the commanders 3-dimensional view might be less than the fidelity of the simulation.

5.5 STEP 5: Categorizing Player Types. Once the PTA and Represented Units are identified, 'players' should be categorized. WARSIM 'players' are composed of commanders, staff sections, individual staff members, and Role Players or CGF operators (see Figure 5-2.). Although the degree of Role Player participation will be dependent on the WARSIM architecture, consideration of this requirement up front during PTA definition is important to the system design because it will define the level of task detail which must be supported by the simulation and/or assist the developer apportion functionality. Staff section tasks, for example, may require less fidelity at the 'represented unit' level than tasks performed by individual staff members. Similarly, a role player commander could represent the cognitive "commander functions" while the simulation provides the automated staff functions in response to commanders decisions or actions.

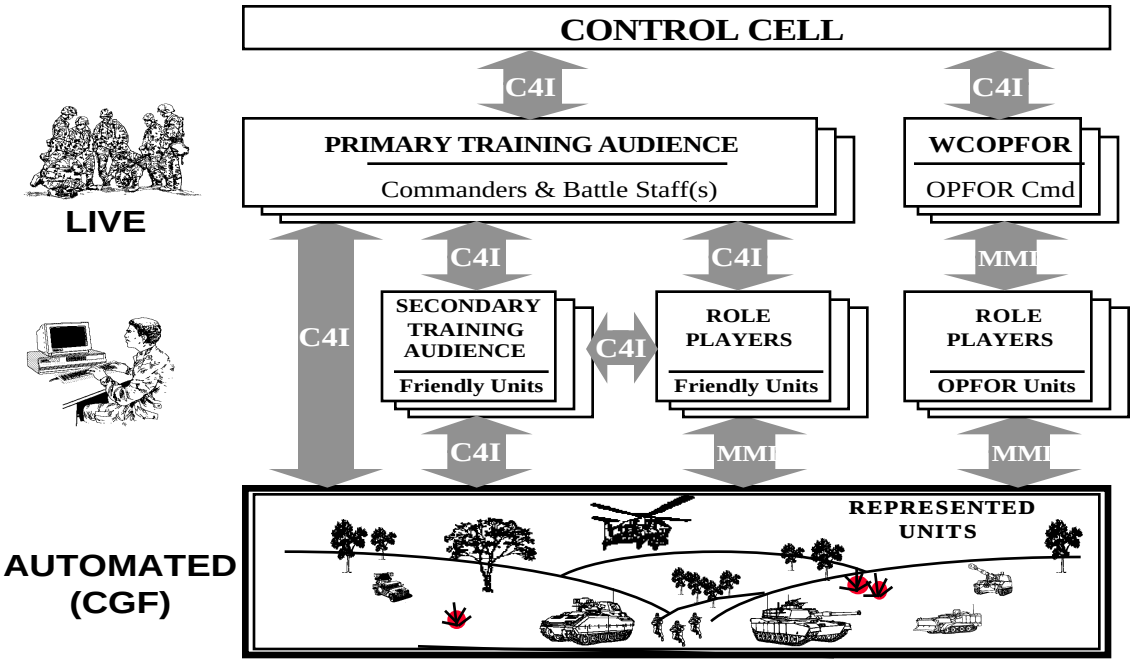

FIGURE 5-2
WARSIM Employment Concept / Player Types

Specifying this partial function up front may result in a more efficient MMI for 'commander role players. Though further definition will be required, the following are suggested criteria for each category of player:

Primary Training Audience (PTA): Uniformed trainee operating in his real environment using his real C4I systems.

Secondary Training Audience (STA): Uniformed trainee subordinate to the PTA and operating from his real environment using his real C4I systems.

Role Player: Uniformed trainee or SME responding to plans, orders and directions from the PTA/STA. A Role Player represents either an entire unit or command entity.

CGF Operator: SME controlling subordinate or supporting unit(s) IAW established doctrine.

5.6 Review, Prioritization, and Approval. NSC must review, prioritize, and approve the products of this process to ensure that all user operational training requirements are adequately addressed and the transformation of the tasks can be efficiently integrated into object-based information understandable by the simulation developer. Priorities of "decomposed" information products should align with the developers 'build' schedule.

Further, while the process has been listed in a sequential order, in practice it will be iterative. Nonetheless, once a baseline has been established and approved by NSC, all future changes will have to be negotiated between the combat developer and the materiel developer to ensure that changes are matched back to original user expectations. The application of TPSCs or a similar methodology will facilitate the trade off decisions.

6.0 BOUNDING THE SOLUTION.

While the five-step WRDFD process provides a structured process for decomposing the WARSIM requirement to, "support training of commanders and staffs from battalion through Theater level...", it lacks the means to bound the solution which it is intended to generate. For this purpose, use of Warfighter XXI Training Support Packages (TSPs) should be considered. A Warfighter TSP, as defined in TRADOC Regulation 350-70, is a collection of all necessary information to describe a unit training scenario including the training audience, tasks to be trained, conditions, storyline, orders, overlays, OPFOR and O/C instructional material, etc.. As such, they provide structure, context, and degree of detail for deciding on both PTA and PTA tasks.

6.1 Context. The TSP provides the necessary context to make decisions to include or exclude tasks and units, identify role player requirements, specify design interfaces, and determine synthetic environment objects and their behaviors. For example, approval of a Division Attack TSP which contains a deliberate breach of a complex obstacle as part of a Brigade Deliberate Attack will guarantee a detailed combined arms assessment of the brigade-level PTA and PTA tasks associated with this specific mobility operation together with the subordinate units and unit tasks which must be represented in WARSIM. Without this context, the user will have no objective basis for including or excluding tasks and units. TSP will also assist in identifying synthetic environment characteristics and objects which must also be represented. Finally TSPs will help identify tasks not contained in MTPs and refine them for inclusion in doctrinal sources.

6.2 Task Environment Matrix. Figure 6-1 provides a suggested matrix of WARSIM task environments keyed to accepted doctrinal structures. Each cell of the matrix should contain a limited set of TSPs covering the conflict intensity and/or mission or a vertical slice spanning all echelons. Many TSPs currently exist for combat operations (e.g., BCTP, Ulchi Focus Lens) which can be rapidly assembled for immediate use. TSPs for other conflict phases or spectrum must be developed to provide context for task definition.

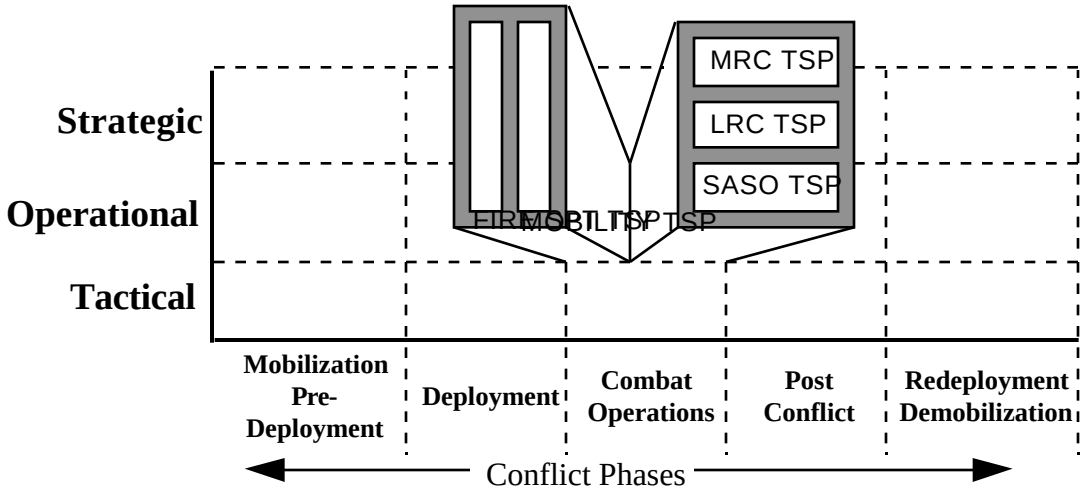

FIGURE 6-1
WARSIM Task Environments

7.0 FUNCTIONAL DESCRIPTION OF BATTLESPACE.

The Functional Description of the Battlespace (FDB) is a system that documents standard accurate, validated, and traceable descriptions of the components and characteristics of battlespace functions. These descriptions of battlespace functions can be used to produce credible simulations of these functions. The FDB is under development by STRICOM, in conjunction with NSC. The FDB development and the WRDFD process are concurrent efforts with WARSIM being the first application. The long term goals of the FDB are to:

- Collect data relevant to the Modeling and Simulation community
- Transform collected data into useful information, and
- Present information in a domain specific view for each functional user.

7.1 Background. The FDB contract was awarded to Veda, Inc. on June 1995. Subsequently, Veda sublet contracts to Resource Consultants, Inc. (RCI) and Innovative Management Concepts (IMC) to support their work on the FDB. The FDB is designed to meet the needs of simulation builders in the collection of validated, standard descriptions of battlefield functions, physical algorithms, equipment characteristics, and terrain data.

7.2 Data Collection. Source data is the simulation independent bottom tier on the information scale that feeds simulation specific information and knowledge. The WARSIM data collection effort will be focused on the schedule of needs provided by the simulation developer. This data will describe the physical characteristics of equipment,

organizational break down of the units, and required duties of those units applicable to the simulation domain. Once the data is collected, it is combined and transformed into information using both a textual and graphical approach. The products of these approaches are intended to be complementary and apply to both PTA tasks and represented unit tasks. Authoritative data sources used for the FDB data collection must be in accordance with the Standards Category Coordinators identified in the Army Modeling and Simulation Master Plan. Sources of data and information that have been identified include:

- **US Army Materiel Systems Analysis Activity (AMSAA).** AMSAA is expected to provide algorithms for physical and environmental processes and/or event.
- **Topographic Engineering Center (TEC).** TEC is expected to provide terrain and environment data and algorithms.
- **US Army Research Lab, Battlefield Environments Directorate (BED).** BED is expected to provide weather related data.
- **US Army Research Lab, Human Research and Engineering Directorate (HRED).** HRED is expected to provide human characteristics data.
- **Program Executive Offices (PEO) and Program Managers (PM).** PEOs and PMs are expected to provide data relevant to the physical characteristics of their systems.
- **US Army Combined Arms Support Command (CASCOM).** CASCOM is expected to provide combat service support data for supply and maintenance issues.
- **TRADOC Combined Arms Center, Threat Directorate (CAC-T).** CAC-T is expected to provide data to describe foreign equipment, tactics and organization.
- **TRADOC Schools and Battle Labs.** The TRADOC schools and battle labs are expected to provide data describing the Army organization and function.
- **Legacy Simulation Systems.** Significant data is available from legacy simulation systems (e.g., CCTT). Although most of this data is not well organized or connected, it should prove useful to the initial effort to populate the FDB.

Data, Information and Knowledge**.** It is important to make a distinction between data, information and knowledge. For purposes of this process, the definitions shown in Table 7-1 will be used. Wisdom is the forth level of information that takes knowledge a step further. This forth progression is beyond the current scope of the

Data	Collections of unconnected facts.
Information	Meaningful result derived by associating facts within given context.
Knowledge	Consequential result of associating information from one context with information from another context.
Wisdom	Generalized principles derived from disparate knowledge.

Table 7-1
Data, Information and Knowledge

WRDFD process. The majority of input into the FDB is in the form of data. That data will be processed into information and documented in the TPDs. Within the FDB, TPDs

will be merged into the Object Repository and connected with equipment characteristics to comprise an Army Object Model to represent knowledge of the real world Army. The process is shown in Figure 7-1.

Task Process Description (TPD)**.** Task Process Descriptions combine MTPs, Critical Combat Functions (CCFs), Field Manuals (FMs) and other relevant data into information describing how Army tasks are performed. The purpose of the TPD is to impose a standard method for describing the tasks performed by the command staff and the related tasks performed by other units during combat operations. The TPD format consists of ten parts: the task identification, the task description, the associated tasks, the input required, the time to complete, the output provided, supporting objects, resources required, references, and associated code and simulation algorithms. A discussion of each section is included in this paper as Appendix A. TPDs are completed by FDB contractors who are subject matter experts (SMEs) working in conjunction with an object modeler to develop an Army object model. Upon completion of a TPD, it is added to the FDB document repository for review, correction and validation by the appropriate TRADOC subject matter experts that are designated by NSC for validation.

After validation, the TPD is stored as a validated document in the document repository and incorporated into the FDB's Object Model (OM). This is not a trivial task, since one TPD may involve several actors and many pieces of equipment. Doctrinal references pertinent to the TPDs will be accessible through dynamic links to the document repository which will house electronic copies of all documents referenced by the OM. During the implementation of the OM, the TPDs residing in the document repository can be linked to the OM through Hypertext Markup Language (HTML) or Java links. As the TPDs are linked into the OM, the OM must continually be submitted for validation.

Behavioral diagrams. Behavioral diagrams will be created for most critical training tasks using a systems engineering documentation software application. These behavior diagrams are pictorial representations of the flow and interrelationships of the tasks and the participants. To develop the diagrams, the doctrinal references for the tasks being described are researched, and an In/Out Matrix which graphically depicts the inputs, outputs, and players involved in the task is developed. This matrix is created in coordination with TPD authors to establish a common baseline for both processes. Once the matrix is complete, a behavioral diagram which presents a flowchart-like graphical depiction of the same processes involved in the task described in the corresponding TPD is created. Thus, the same data is presented both graphically and textually to empower the user with a better understanding of the tasks being described. These diagram will be linked to the TPDs within the FDB.

Document Repository**.** The FDB Document Repository (DR) is intended to be a research tool to provide the technical, operational and other documents. The DR

is intended to support Army modeling and simulation development specifically and the modeling and simulation community in general. Interactive access is provided on-line across the World Wide Web to include links to other internet accessible databases as appropriate. The document repository must contain references to doctrine, tasks, and procedures. The primary purpose of the document repository is to provide a valid source of background information a simulation developer can reference when more information is needed on a particular issue. The Document Repository has two principal goals:

- Any technical reference made in the FDB object repository will be made available for viewing within the context of the FDB.
- Critical literary reference, as identified by the FDB Executive Council, needed to support modeling and simulation will be made available for viewing within the context of the FDB.

Configuration Management. As with any database, configuration management (CM) in the FDB is critical. The FDB is being implemented as an internet accessible, distributed database with the ultimate vision to link to other internet accessible data sources. Because of this, configuration management policies and procedures need to be developed separately with respect to internal and external data. Internally, the most stringent requirement for CM in the FDB is the ability to trace to a data configuration for a specific day in time. The nature of the contracting process requires that the simulation developers build their systems to a specific data set. Within the FDB, those data sets will be controlled by tracking the date of all changes. In order to have complete traceability, a developer requires the ability to recall the data configuration at any point in time. In order to satisfy this requirement, each object or document is tagged with a the date of approval, and all versions of that object are retained either in the FDB or in an archive. Using this approach, each individual piece of information in the FDB carries its own configuration. FDB users can access different configurations by setting the desired date in the preferences. If no date is specified by the user, the most recent version of each piece of data is presented.

The issue related to CM of external data is the lack of FDB control. Within the FDB, source data is used as a starting point to develop value added information and knowledge by relating numerous pieces of source data together within a specific context. If the source data is being changed independent of how the FDB is using that data, the value added nature of the FDB can be significantly degraded. If the FDB is to link to other similarly accessible databases, specific CM procedures must be developed and followed. Developing external CM procedures will be performed on a case-by-case basis through a memorandum of agreement (MOA) or similar document. The MOA will describe the specific procedures to be followed by each party.

Traceability to Doctrine. All objects and processes described in the FDB OM will include the specific doctrinal references which were used in their development. These references will include, as a minimum, the title and publication date (and author/publisher, if necessary). As described above, doctrinal references supporting object definitions will be included in the document repository for on line access through the FDB.

SME Forum. The FDB Forum is as an on-line communication capability which allows the simulation and Army communities with similar interests to form communication groups. These groups, dubbed "Special Interest Groups" (SIGs) by the Internet community, provide a preserved area for common users, SMEs, developers and administrators to exchange information on related topics of interest. FDB users, principally simulation developers, require a means to present questions to the appropriate group of SMEs responsible for the validation of doctrinal, technical, and other data relevant to their domain of expertise. The Forum supports CM in providing a traceable structure for this information exchange by archiving all queries and official responses. It also supports administrative functions by providing a convenient means for traceable communications between the various organizations and groups involved (e.g., FDB Administrators, Data Approval Group, FDB Working Group, etc.).

Algorithms. The FDB will provide a repository for algorithms that have been approved for a specific use. Due to the potential misuse of algorithmic data, all such algorithms must be tightly controlled with rigid conditions and precautions for their use. The conditions for use must be provided from the algorithm developer when the algorithm is submitted for inclusion in the FDB and subsequent use in a simulation.

7.3 Transformation of Data into Information and Knowledge. The measure of effectiveness for the WRDFD process and the FDB will be the ability to communicate information and knowledge about *how* the Army operates to simulation developers. It has often been said, “If you can describe it, I can simulate it”. For an upper echelon command and staff trainer, the heart of that description must be more than source data. The converse also applies, if the Army cannot describe what it wants simulated, the simulation developers will not be able to develop effective code for training. The process for transforming source data into useful knowledge is shown in Figure 7-1. This process begins with the simulation independent source data, then transforms that data into simulation specific information to support development of the target simulation system. Since the level of detail for these descriptions is driven by the required level of detail for the target simulation being developed, the descriptions become simulation specific. The descriptions will be reusable. However, the descriptions will need to be processed through the verification, validation and certification process within the context of the new simulation system. Within the FDB, the object repository will be contain the information and knowledge along with links to document and traceable relationships to the data.

Object Repository. The FDB Object Repository (OR) is intended to be an object oriented description of the Army. The definitions are intended to be non-rigorous in the conventional sense of object oriented methodologies. The definitions are required to be approved and traceable to both approval agents and doctrinal reference. Simulation builders will be required to produce simulation models consistent with, but not necessarily identical to, FDB defined models.

As discussed earlier, the collected data is transformed into information and documented in the task process descriptions. Multiple TPDs are then combined with the OM which results in knowledge that is documented in the FDB object repository. The object repository then becomes the source for the most mature simulation development resources.

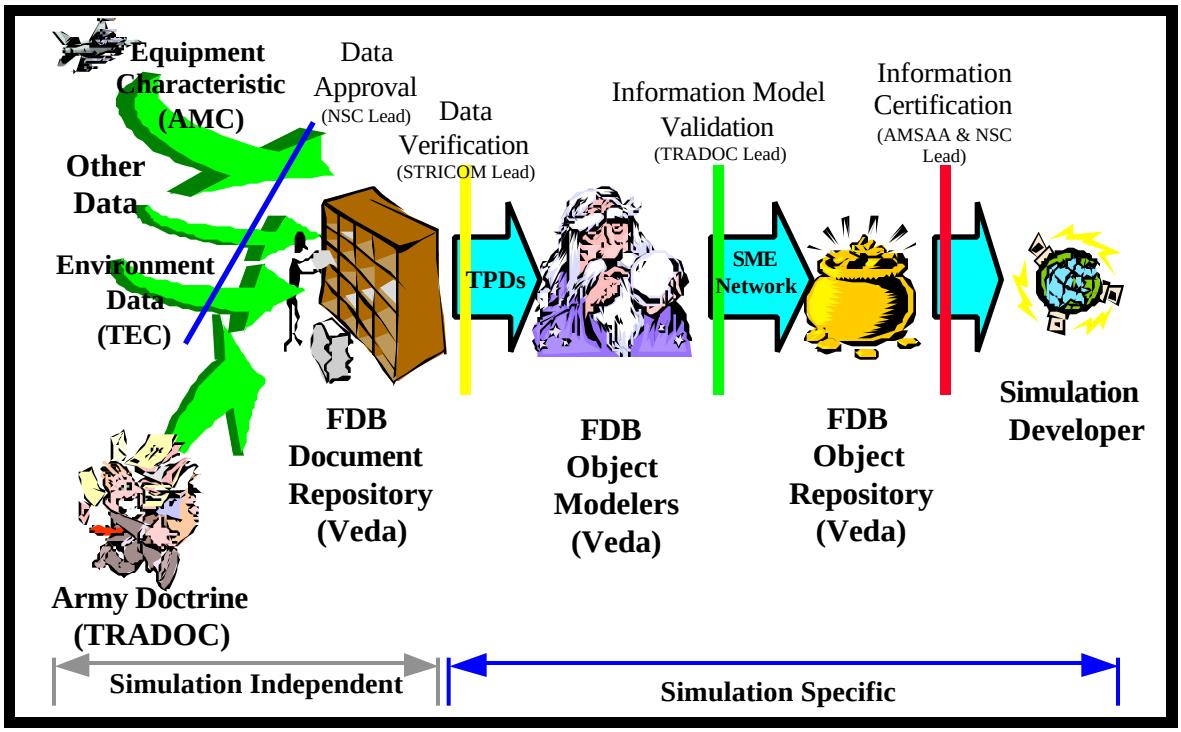

Figure 7-1:
Data to Information Transformation

It is the object modeler's job to design a logical OM to support the tasks that have been described in the TPDs. The design and implementation of the OM is one of the most critical parts of the FDB project. If properly designed and implemented, it will bridge the gap between Army experts and software experts.

7.4 Approval, Verification, Validation and Certification. To support the verification, validation and certification of a simulation developed using FDB data, that data must be appropriately endorsed by the user community. As stated in the February

1996 draft of the *DoD Data Verification, Validation, and Certification (VV&C) Guidelines for Modeling and Simulation,;*

> "Data quality must be understood to include the appropriateness of data for their intended use. Even when data are consistent and accurate, they may not be suitable for use in a specific model or appropriate for a specific application: they may be incompatible with the requirements of a model or may be based on assumptions that are inconsistent with the intended use of the model. If the results of a modeling effort are to be believed, the data used in producing those results must be made at least as credible as the model itself, and the justification for this credibility must be made known."

Performing VV&C within the context of the intended use of the data is a driver for the simulation specific aspect of the FDB. Based on the DoD VV&C Guidelines, a four step plan has been developed to complete this user endorsement. Working groups have been established under the guidance of the FDB Executive Council to support each step. For purposes of the FDB, definitions for each of the four terms are shown in Table 7-2. The processes associated with each of these four steps are described in the following paragraphs.

Approval	Acceptance of a data set for inclusion in the FDB.
Verification	Acceptance of an approved data set as relevant to a specific simulation.
Validation	Acceptance of information, developed from a verified data set, as an accurate representation of the real world.
Certification	Acceptance of data, information and/or knowledge, developed from a valid information base, as having the appropriate fidelity and resolution for a specific simulation.

Table 7-2
Approval, Verification, Validation and Certification Definitions

Approval. Approval of a data set is a necessary prerequisite for all FDB data. Data approval is the responsibility of the FDB Data Approval Working Group. Given the definition of data from Table 3-1, the main focus of data approval is acceptability of the source data as facts. Approved data is marked as such and made available to the simulation developers in the document repository.

Verification. Once a data set has been approved, the data is available for analysis as to its relevance to a particular simulation. Data verification is the responsibility of the FDB Data Management Working Group. A determination of relevance will depend on the particular simulation type that is being developed and the design approach being used by the developer. Data verification will need to be done for each simulation type being developed. Within the FDB, the data will need to be

appropriately identified as verified for each type of simulation. Data which is not verified by the Data Management working group, may still remain in the FDB as unverified for a particular simulation.

Validation. Information should only be developed based on verified data. Once the information has been developed, it must be validated. Data and information validation is the responsibility of the subject matter experts assigned by NSC. The goal of the validation is to ensure that the data and generated information are accurate representations of the real world. The subject matter experts are expected to provide comments and/or corrections as appropriate if they determine that the information is not valid. The SMEs should always be asked to review the data and information, not to develop it themselves. Once validated, the information is marked as valid for the particular simulation type.

Certification for Simulation Development. Certification is required for all data, information and knowledge that is to be included in the simulation. Certification responsibility is split among two FDB working groups. The Physical/Environmental Data Group will be the certification authority for data, information and knowledge describing the physical characteristics and environmental effects. The Cognitive Data Group will be the certification authority for data, information and knowledge related to the Army organization and the associated cognitive processes. The FDB Executive Council has the authority to designate to which group a data set should be assigned.

7.5 Data Security. The FDB will initially contain unclassified, For Official Use Only (FOUO) and otherwise sensitive or restricted data. To preserve data security, access to the system must be tightly controlled. Due to inherent internet security limitations, the initial version of the FDB will not contain any data classified as secret or higher. The problem is being approached in two ways. First, we are following the developments in the area of internet security. There is significant interest in the internet community to provide more secure transmission. As solutions are developed, they will be evaluated for applicability to the FDB. The second approach, is to investigate alternatives designs to make the FDB system more secure. As a fall back position, a CD-ROM could be developed containing the classified information. Distribution of the CD-ROM would be controlled. This would eliminate the need to transmit the data over internet lines, but would also complicate the system.

The FDB itself will be protected by a combination of components incorporating a Firewall network security system, Netscape™ secure software, and internal software controls and policies. Further, FDB data will be incrementally archived on a daily basis and a complete system backup performed on a weekly basis as per the FDB CM Plan.

8.0 INFORMATION TRANSFER

8.1 Identification of WARSIM 2000 Relevant Data. An important step in the information transfer process is identification of the WARSIM specific data. Several different situations have been anticipated regarding the identification of simulation specific data. The first is that the data required by the simulation developer is existing Army data (equipment characteristics, doctrine, weather information, etc.) that is already in the FDB document repository, or can be easily collected and included. Since the data must be approved prior to inclusion in the FDB, the data can be used directly out of the repository.

The second situation is that the simulation developer requires data that does not exist in the Army, but can be easily generated or derived from existing data. When this situation occurs, STRICOM will need to negotiate with the data owner to have the data developed, validated and approved prior to inclusion in the FDB and subsequent use by the developer. A critical aspect of this situation is sufficient lead time.

The third situation is when the unique aspects of the simulation design require data that does not exist in the Army and cannot be naturally derived from existing data. Under this situation, a agreement must be reached between the simulation developer, STRICOM and the combat developer to determine how the data will be developed, approved, and validated. An example of this situation is if the simulation design dictates a combat attrition algorithm not consistent with the set of Lancaster equations, another set of equation will need to be developed, approved, and validated. The FDB team and the simulation developer team need to work closely to identify required data and determine which situation is falls under.

8.2 Different views of Information. One of the more challenging aspects of presenting data and information is consideration of the relevance of a piece of data to a particular user. Each type of user is interested in different a different slant of the information. For example, a logistician and a warfighter have different interests in an M1A1 tank. Both views must be supported by the FDB. Complicating this issue is different user types want to look at the same information differently. An example of this is a logistician and a simulation developer working on a logistical simulation have different views of the information. The initial user interface for the FDB has been focused on the needs of the primary user, the simulation developer. The FDB Contractor (Veda) is investigating potential methods for displaying FDB data in varying formats, customized to the user's level of expertise or background.

8.3 FDB Access. The FDB is a platform independent, internet accessible database system. Access to the FDB requires a Java compliant world wide web browser and an assigned user ID and password. STRICOM will be the approving authority for all potential users requesting access to the system. The FDB Administrator (Veda) will issue user IDs and passwords via US mail only to STRICOM authorized users.

8.4 Traceability to FDB. To effectively support future verification, validation and accreditation of the simulation models, there must be a traceability process to track the origin of the information used to develop the models. With very few exceptions, this traceability should point directly back to the FDB as the originating sources.

8.5 Impact of Information Change to Simulation Development. An agreed process must exist to handle and evaluate the impact of changing FDB source data, information and/or knowledge. A process is required for both evaluation within the FDB and evaluation by the simulation developer relying on the information that is changing. The combat developer is responsible for developing the process to trace changing doctrine and articulate the impact of the change on the WRDFD and FDB products. The material developer is responsible for configuration management and traceability of data models and algorithms within the FDB and simulation software. Careful consideration needs to be given to the authorities and responsibilities associated with these processes. The FDB should provide the automated tools to support both of these processes.

9.0 SIMULATION DEVELOPMENT

9.1 Development Need for WARSIM FDB. The WARSIM IDT users of the FDB will require access to a variety of types of information throughout the WARSIM development life cycle. The following sections outline these requirements.

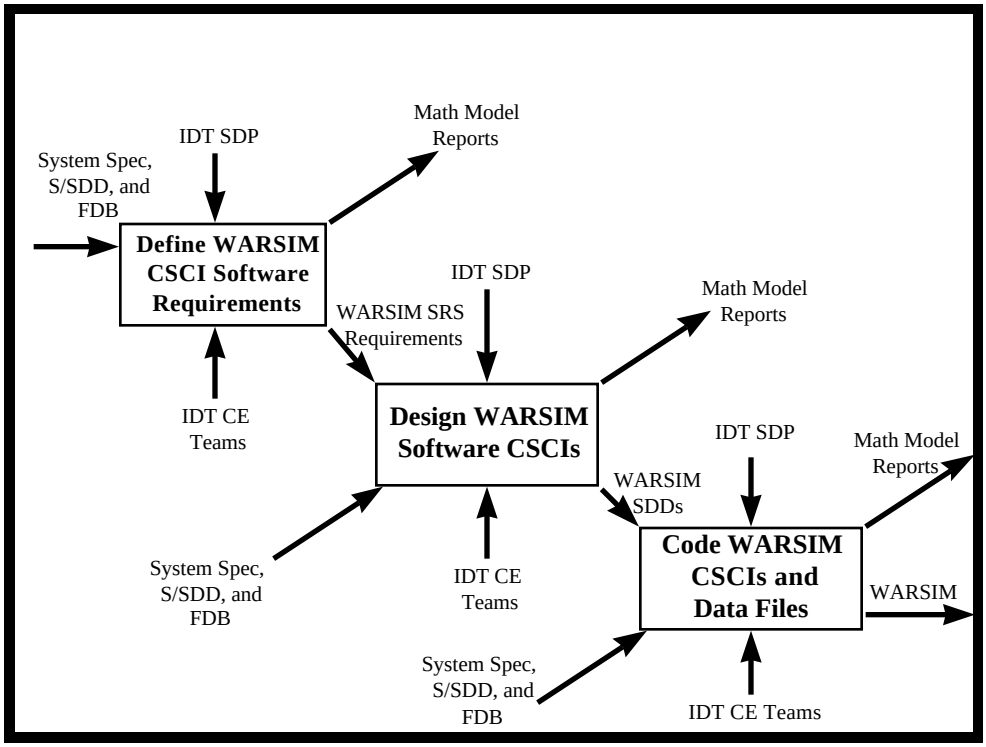

FIGURE 9-1

FDB Use Throughout WARSIM Development Life cycle

9.2 Complete Life cycle Support. As shown in Figure 9-1, the FDB will support the WARSIM developer through the development life cycle. The software development processes for WARSIM are described in their Software Development Plan (SDP). The process involves developing several CSCIs during multiple spirals. Information from the FDB will be translated into computer representations during the software engineering process. The FDB will provide a traceable source for the development of the Software Requirements Specification (SRSs).

System Requirements Analysis FDB Needs. The System Requirements Analysis phase of the WARSIM development effort will result in documenting system level requirements in the System Specification. The PTA descriptions for WARSIM will help scope the entire WARSIM development life cycle. The units, equipment, and tasks to be simulated in WARSIM will be derived from the PTA and the tasks to be trained. These items are enumerated in Appendix B of the WARSIM System Specification. Although these items will be documented in the FDB, access to the FDB will not be required to access this information during the systems requirements phase.

Software Requirements Analysis FDB Needs. The software developers defining requirements for the WARSIM system will need access to doctrine descriptions and operational systems in order to sufficiently understand them for specification as software requirements. Additionally, FDB support should be provided to these software developers to access general Army information. The WARSIM CSCIs SRSs will document the software requirements. These requirements will be analyzed using an object-oriented analysis approach. Software developers will need to understand the "real world" objects to adequately describe their software requirements in an object oriented fashion.

Traceability to the FDB. As software engineers document their requirements, they must trace each of their requirements to a driving system requirement. They also need to trace the FDB as the source data for some of those requirements. The traceability to the FDB will be documented in the math model report and recorded using the DOORS tool.

Software Design FDB Needs. In order to correctly model a system, the software developers will require access to information describing "how" the Army operates in the real world. This information will be crucial in the design of the software algorithms and processes. Software developers will design their CSCIs using an object-oriented design approach. As with the SRSs, the SDDs will need to trace back to the FDB and be documented in the math model reports and recorded using DOORS.

Execution FDB Needs. Some information will be required from the FDB when the WARSIM system is executed. The primary uses of the FDB at execution time are the scenario generation and data files inputs. Both this uses will be fed from FDB data, but not directly connected at runtime.

9.3 Data Requirements Schedule. A schedule of the data requirements to support simulation development will be provided to the FDB. The probability is high that some data will not be available in the FDB when it is needed by the developers. A process has been developed to handle this situation. The process is shown in Figure 9-2.

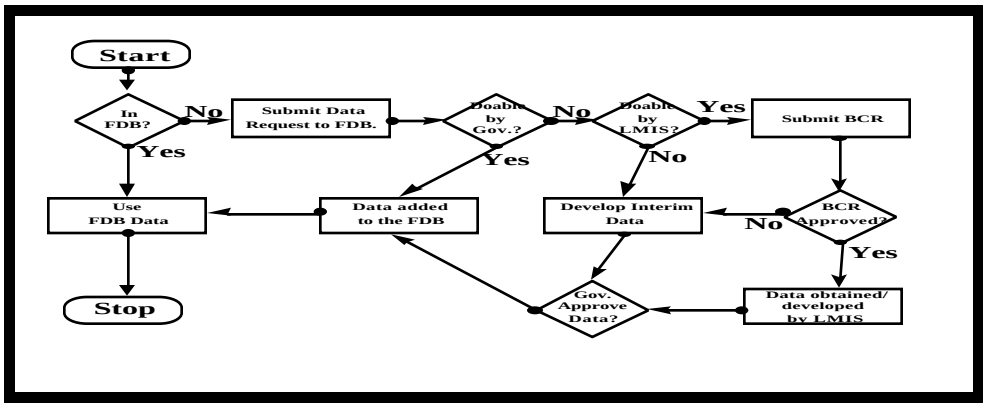

FIGURE 9-2
Approach to Obtain Data Not Available in the FDB.

10.0 Simulation Execution Support. The WARSIM 2000 scenario generation software will utilize data that is derived from the FDB. The FDB will not provide an on-line capability for data transfer for scenario generation or system initialization directly to the simulation.

11.0 Other Development. This development process must monitor and closely work with similar developments from the other services and joint community. The specific programs affected are the CMMS, JMSM, and the MSRR.

12.0 Baseline of Legacy Systems . Although it has never been stated as a requirements, an advertised goal of the WARSIM 2000 system is to replace several existing simulation systems. Most of the system being replaced are the Army component of the ALSP confederation. These systems include the Corps Battle Simulation (CBS), Brigade/Battalion Simulation (BBS), Tactical Simulation (TACSIM), and Combat Service Support Training Simulation System (CSSTSS). In order to assess the degree of achievement of this goal, the capabilities of the legacy systems must be studied until a common understanding is shared. To support common understanding, it is suggested that the legacy systems be analyzed using the criteria described in paragraph 2.

13.0 References:

a. Warfighters' Simulation 2000 Operational Requirements Document, 25 August 1993.
b. Warfighters' Simulation 2000 System Specification, Lockheed Martin Federal Systems, 27 June 1996.
c. Functional Description of the Battlespace (FDB) System Specification (Spiral 1), Veda Inc., 8 December 1995.
d. Implementation Plan for the Functional Description of the Battlespace, MITRE Corp., 21 June 1995.
e. Charter for the Functional Description of the Battlespace, May 1995.
f. Data Verification, Validation and Certification (VV&C) Guidelines for Modeling and Simulation, Under Secretary of Defense (Acquisition and Technology), draft February 1996.
g. The Army Modeling and Simulation Master Plan, Headquarters Department of the Army and Office of the Deputy Under Secretary of the Army (Operations Research), 18 May 1995.
h. "WARFIGHTERS' SIMULATION 2000, A Personal View - Part I", Ms. Annette Ratzenberger, undated.
i. White paper, "Architectural Requirements for the Functional Description of the Battlespace", Veda, Inc., 6 June 1996.
j. CJCSM 3500.04, Universal Joint Task List, V2.1, 15 May 1995.
k. Joint Mission Essential Task List (JMETL) Development Handbook, 15 Dec 1995.
l. AMCPM-CATT Memorandum, dated 23 February 1996, Subject: CATT Requirements Decomposition and Functional Definition (RDFD) Process.
m. AMCPM-CATT Memorandum, dated 29 March 1995, Subject: Review of Synthetic Environment Requirements and Data Representation and Interchange Mechanism.
n. AMCPM-CATT Memorandum, dated 5 December 1994, Subject: Data Management.
o. AMCPM-CATT Memorandum, dated 11 June 1996, Subject: SEDRIS Update.

APPENDIX A

EXPLANATION OF THE TASK/PROCESS DESCRIPTION FORMAT

Revised 25 Mar 96

A.1 General. This document provides an explanation of the various components which comprise the Task/Process Description format. It is intended to assist Subject Matter Experts (SMEs) during the review and validation of specific tasks and processes relative to the Functional Description of the Battlespace (FDB) as well as technical personnel (programmers, analysts, etc.) during simulation code development.

1.0 TASK IDENTIFICATION

1.1 Task Number: A unique identifying number for the task being described. The first three characters of the task number indicate the original source of the task:

CCF: Critical Combat Functions
ART: Army Training Evaluation Plan (ARTEP)
MTP: Mission Training Plan
CIS: Combat Instruction Set
XXX: Other

1.2 Task Name: A unique textual name of the task being described.

1.3 Task Source & Date: The specific source requirement document and its publication date for this specific task.

1.4 Parent Task: The top level task requirement.

1.5 Type of Process: Specifies whether the task is:

Physical Dealing with task execution;
Cognitive Dealing with task planning, i.e., assessment, prediction, interaction, decision or direction; or
Cognitive-Physical Cognitive task but yields a Physical output.

1.6 Configuration Management Status: This section details the following configuration management and version control information:

1.6.1 Date of Description Format: Version date of the description format.

1.6.2 Date Created: Date the description was first created.

1.6.3 Date Reviewed: Date the description was last reviewed.

1.6.4 Date Changed: Date the description was last changed.

1.6.5 Date Validated: Date the description was last validated.

1.6.6 Validated By: Name and organization of validation authority.

1.6.7 Date Approved for FDB: Date the Data Approval Subgroup granted approval for this description to be entered into the FDB under approved status.

1.6.8 Date Maintenance Review: Date of last maintenance review.

1.6.9 Date Task Changed/Updated: Date the description was last changed/updated.

2.0 TASK DESCRIPTION: Provides a short textual description of the primary task being described

2.1 Task Details: Provides a short textual description of the subtasks and task elements necessary to successfully complete the task being described. This may include a short task summary from the reference(s) and SME experiences, including the steps to complete.

2.2 Task Priority: A subjective priority ranking assigned to the task being described comparing it to other tasks which share the same parent task (see section 1.4, above). Possible values are High, Medium or Low and indicate the relative importance of completing this task to the successful completion of the parent task.

2.3 Who Performs the Task: Individual, element or unit responsible for completing the task.

2.4 Preconditions: Conditions which must exist before the task may be initiated.

2.5 During Conditions: Conditions which must exist during task execution.

2.6 After Conditions: Conditions which must exist following task completion for it to be wholly successful.

3.0 ASSOCIATED TASKS

3.1 Interrupting Tasks: Other tasks which force halting this task and switching to another.

3.2 Concurrent Tasks: Other tasks, performed at the same time as the task being described, that may impact on the described task.

3.3 Coordination Tasks: Other tasks that must be completed together to synchronize the use of resources and accomplish the results.

4.0 INPUT REQUIRED
(Note that a separate set of input data is required for each task input)

4.N Input Name: Identifies the source of the input for this task.

4.N.1 Associated Tasks Providing the Input: Identifies associated tasks whose output provides the input for the task being described.

4.N.2 Originator of Input: Identifies who or what created the input (sensor equipment, unit, person, etc.)

4.N.3 Input Details: Describes the task input.

4.N.4 When or How Often Provided: Describes at what times or time interval the input is provided.

4.N.5 Method of Transmission: Describes how the input is transmitted (Radio, MCS, hand signals, other C2 equipment.)

5.0 TIME TO COMPLETE

5.1 Duration Distribution: Specifies a time range(s) within which to complete the task - i.e., minimum, maximum, average and/or standard deviation - to help develop a distribution.

5.2 Events that Significantly Effect Task Duration: Identifies any outside events that may force the task to be completed faster or slower than normal circumstances.

5.3 Probability of Successful Completion: This data field drives mistake generation. Since the proper outcome will be known ahead of time by the simulation truth, this field may be used to specify a probability factor (0.0 - 1.0) to determine if the "correct" outcome is determined.

6.0 OUTPUT PROVIDED
(Note that a separate set of output data is required for each task output)

6.N Output Name: Identifies which products (outputs) are produced by completing this task (i.e., OPORD, *FRAGO*, etc.). Other tasks referencing these same products will be HTML linked.

6.N.1 Output Details: Describes the task output.

6.N.2 Associated Tasks Receiving the Output: Identifies associated tasks whose input requirement is satisfied by the output of the task being described.

6.N.3 Recipients: Identifies who or what receives the input (sensor equipment, unit, person, etc.)

6.N.4 Method of Transmission: Describes how the output is transmitted (Radio, MCS, hand signals, other C2 equipment.)

7.0 SUPPORTING OBJECTS (Enclosed by * in the main body): This section identifies the format and description(s) of all known supporting objects such as OPORD, *FRAGO*, Annexes, *R&S Plan*, overlays such as the MCOO, etc.)

8.0 RESOURCES REQUIRED

8.1 Personnel Required: Identifies the personnel required to accomplish the task being described.

8.2 Equipment Required: Identifies the equipment required to accomplish the task being described.

8.3 Supplies Required: Identifies the supplies required to accomplish the task being described.

9.0 REFERENCES

9.1 Training References: Identifies training reference documents and their publication dates with specific application to the task being described (MTPs, ARTEPs, etc.) Other tasks associated with these same references will be HTML linked.

9.2 Governing Doctrine References: Identifies training reference documents and their publication dates with specific application to the task being described (FMs, TMs, Standards, etc.) Other tasks associated with these same references will be HTML linked.

10.0 ASSOCIATED CODE & SIMULATION ALGORITHMS: This section is for use by EMD contractors who must indicate here the code module(s) or algorithm(s) that are used in their simulation to replicate this task/process.

10.N.1 Algorithm Name: Identifying name of code/algorithm.

10.N.2 Algorithm Description: Short textual description of the code/algorithm.

10.N.3 Conditions for Use: Specific conditions for use of the code/algorithm.